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MANUAL TRAINING AND GOOD CITIZENSHIP

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For the use of the eighth grade of the Francis W. Parker school, in the fall of 1904, the room formerly furnished as a library was turned into a grade room. The library shelves on the south wall were boarded up to afford space for blackboards; but since there was no cupboard in which to keep materials, those covering the whole east wall were left — an unsightly length of open shelves, eight feet high. In all other respects the room is a very attractive one, with the north wall broken by three dormer windows which give a pleasing view of the park and there is a satisfactory absence of cross-light.

At the beginning of the year the pupils of the grade saw at once the admirable features of the room and its disfiguring shelves as well, and recognized the necessity of amending the appearance of the east wall. This became the problem of the class for the winter quarter in their work in art and manual training.

A few of the designs which were made and rejected are shown, to make clear the advance in taste which the children undoubtedly achieved before they found a plan which pleased them. The canons of taste which they established for themselves show constantly in their attitude toward interior decorating and their interest in it. The visible result of their work in design and execution is to be seen in the photograph of the finished work shown at the head of this article. There were other results which were also of some interest.

The class has been engaged all the year in a study of Chicago. It is possible in an eighth-grade civics class to study the problems

of a great city, and the way such a city as Chicago is trying to solve some of these problems. It is far from desirable to call the attention of such a class to the distressing aspects of municipal conditions. That is to say, it was worth while to make an excursion down the Drainage Canal, and another to the cribs; to study the history of our drainage and water-supply; to see why our problem was more difficult than that of seaboard cities; to make maps and diagrams for the use of next year's class; to see the expense attendant upon correcting our terrible mistake of draining sewage into the lake; and to find out how taxes are levied to pay this expense, and why the state government had to authorize the organization of our drainage board. But to see the opportunities for corruption which this form of organization afforded was no furtherance to the end of influencing the pupils to good citizenship.

To the lesson that good citizenship consists in actual constructive service to the community — for which lesson their year's work in civics was meant to give a background — their work in manual training in the winter quarter gave the desirable practical application. For three months they put all the skill they had into a piece of work which was not to be taken home, but to remain in the school, to be of use to all succeeding eighth grades, and a pleasure to all who should see it; and they had worked together, each doing the kind of work he best liked and could best do, and feeling responsible for the quality of his particular contribution, and all interested in the excellence of every part. And where manual training can give a class an opportunity to render a valuable service to the community, in a task which develops individual taste and ability, and engenders interest in the work of others and respect for the achievement of others, it seems to be the greatest single influence toward sympathetic, responsible, active good-citizenship.

The description which follows is intended to show how the details of the work were planned and carried out, together with something of the gain in the technique of design and wood-working which was acquired.

The pupils of the grade, after some discussion as to the best

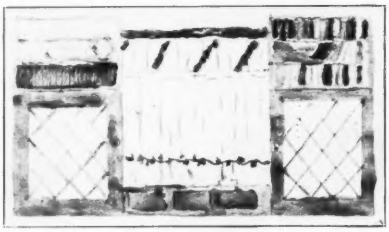

FIG. 2.—Design not accepted

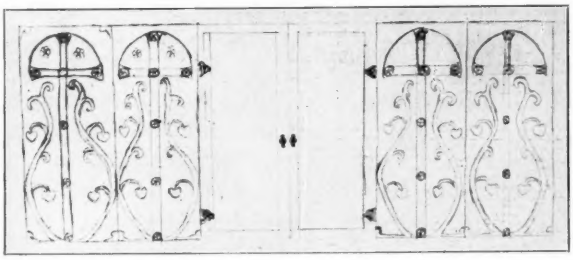

FIG. 3.—Design not accepted

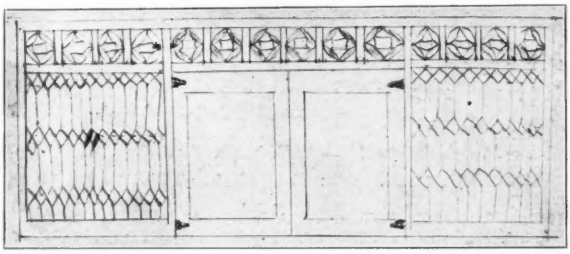

FIG. 4.—Design not accepted

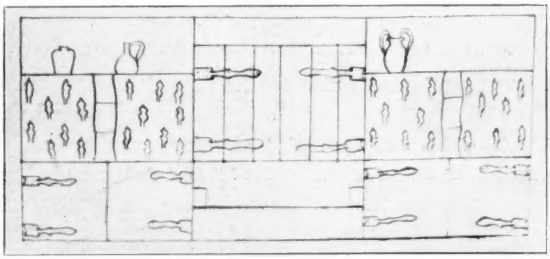

FIG. 5.—Design not accepted

general method of treating the shelves, with a view to securing both sightliness and utility, made several different plans, each child, in fact, contributing at least one. Other members of the school, both pupils and teachers, also were invited to offer suggestions, and this invitation was accepted to some extent, one grade in particular contributing a complete set of sketches.

At this point in the progress of the work, the discussions in the class were upon such questions as the best and most beautiful way to divide the space; the proportion and shape of the divisions —how much space to give to the inclosed cupboards, and how much to the curtained shelves; etc. Rough gray paper was tacked up over the shelves, and different plans were sketched out on it full size, to see how each would actually appear. Some of the suggested plans, which were most favorably considered, and the one which was finally adopted, are shown herewith.

When the arrangement of the closed cupboards and curtained shelves had been decided upon, together with the more important details of construction, such as, notably, the form of door to be used and the style of the bench, (a bench or settle for visitors, to be placed in front of the shelves, had been added to the plan as a hospitable after-thought), the children took different parts to design in detail, and assumed the responsibility for their making.

This selection was made, partly in accordance with the preference of the individual for work of a certain kind, and partly— perhaps to a greater degree—by the consensus of opinion of the grade as to the member of the class best fitted successfully to carry out a certain part of the work.

In working out the design and colors for the curtains, the children made a considerable incidental study of design. They visited Marshal Field's to look at beautifully designed curtains, and the Arts and Crafts shops to see how designs are made and put on.

In designing their own curtains, they tried borders, panel effects, and all-over patterns. After much experimental sketching of this nature, in pencil and color, full-size drawings of sketches most favorably considered were made on the blackboard.

Meanwhile much attention was devoted to the study of color

in general in the effort to select colors which would go well with those of the walls and woodwork. The north lighting, too, was necessarily taken account of in the color scheme.

The final decision was for an all-over pattern of green on tan-colored linen, using the Lombardy poplar for motif, the pattern to be put on with stencil.

In designing the hinge-plates, much the same methods were employed. Some of the children visited the Newberry Library to see designs of hinges, and many drawings were made, and full-size paper patterns cut out, before anything which at all satisfied the class was produced. When the form was finally agreed upon (see Fig. 9), a stiff pattern was carefully made, and the hinge-plates were marked by it upon sheet copper of medium weight. They were then cut out and raised in the center by hammering into a wooden mold made for the purpose.

A number of the members of the class were somewhat dissatisfied with the use of hinge-plates merely for decoration, but as true hinges of decorative type have had to be forged in iron, for which work none of the pupils was prepared, it was decided to use the plates, temporarily at least, as the general style of the doors demanded something of the sort.

For a time the class was anxious to have the space above the large doors of the center cupboard finished in leaded glass, but finally the suggestion was made that it should be finished with copper panels, set into an oak frame, the panels to be decorated in a way to carry out the scheme of decoration used on the curtains. This idea was adopted, and one boy was given charge of that work. The tree designs were carefully drawn on the face side of the copper and outlined with a chasing tool; then the design was raised up from the back, the copper sheet being supported on soft wood, which furnished a sufficiently yielding surface into which to beat the design.

In the woodwork the chief difficulties were encountered in making the long joints required in the doors and bench. As some of these were four feet or more in length, and the wood used was oak, a great deal of care and patience was demanded, and a good degree of skill in accurate planing was developed.

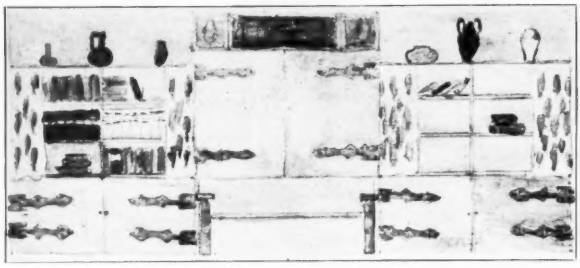

FIG. 6—Accepted design

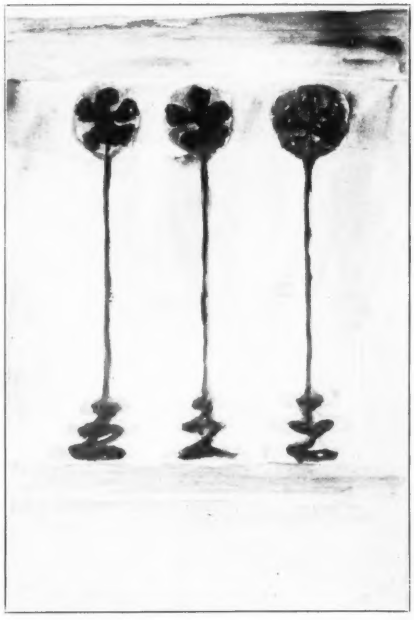

FIG. 7.—Design for curtain not accepted

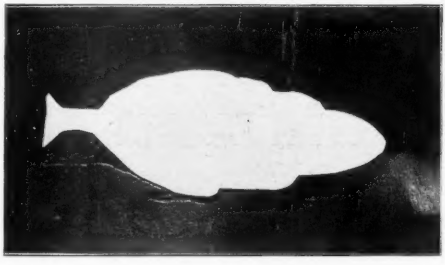

FIG. 8.—Stencil used in decorating curtain

FIG. 9.—Design used for copper hinge

Each joint was amply doweled to insure permanence and rigidity, and cleats were screwed across the inside of the doors to keep them flat.

The children also had considerable trouble in fitting the hinges and hanging the doors so that they would swing properly. Although both the operations were tolerably familiar to them in previous pieces of work, the size and weight of the work added greatly to its difficulty.

In looking over the results of the work, it would seem that the greatest gain, from the technical point of view, in the wood working, was in the handling of larger pieces, the making of the long joints, the setting up and plumbing of the door frames, and the squaring and hanging of the comparatively large and heavy doors, all of which, though really repetitions of operations with which the pupils were familiar appeared, in this larger piece of work, in the nature of new undertakings.

In design, the greatest value of the work was in the incentive it furnished to the children to find out the laws and principles governing good design. The pupils saw that in making their own designs they arrived at pleasing results only after a great deal of experimenting, and that with no certain knowledge to guide them. Even when one of the class chanced upon something which he liked, it was often discovered, upon critical examination, to possess faults and weaknesses which easily might have been avoided, had he possessed some knowledge of the fundamental principles underlying all good design.

The organization of the work, as effected by the children, in a very informal and almost unconscious manner, was very interesting. The interest of the grade as a whole was so thoroughly enlisted in the undertaking that no child thought of not contributing. The natural leaders gradually assumed direction of the work, and carried the responsibility of it, while the less capable members of the group were aroused to their greatest effort.

In a word, the work was great enough, and inspiring enough, from the children's point of view, to incite each member of the class to the highest quality of thought and action.

CHEMISTRY IN THE ELEMENTARY SCHOOL

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[In the development of nature-study within the past decade, no branch of the subject has received so little attention as chemistry. There are several reasons, good and bad, for this neglect. Nature-study has always been more or less clouded with the story-book method, and this branch of the subject does not lend itself easily to such treatment. Fortunately, nobody yet has attempted to introduce the children to chemistry by reporting in story form a familiar conversation between "Mr." and "Mrs. Atom;" nor has anyone yet worked out the infinite literary possibilities that may lie in the detailed tribulations of the little "baby atoms." It is not to be expected, however, that we shall much longer escape a dramatic presentation of the lives of "Papa" and "Mamma Microbe," the effect of which will be to impress upon the vivid imagination of childhood the picture of something like a cross between a rhinoceros and a crocodile.

There is some difficulty in the fact that many of the phenomena belonging to the field of chemistry arise from changes that are obscure in their origin and difficult to observe. But the chief trouble is that most teachers seem to think that the only way to begin the subject is to start with certain experiments relating to chemical change which through endless repetition have come to be known as "classics." Whoever heard of beginning chemistry in any other way than by decomposing mercuric oxide and by combining iron filings and sulphur!

There are, though, many ways in which pupils come into contact with chemical phenomena. When proper attention is given to it, no other aspect of nature is more profoundly interesting to children. The following outline is intended to illustrate some of the points of contact which the child makes with the subject in his ordinary experiences, leaving it to the sense of the teacher to see how such work should be carried out in detail.— NOTE BY THE EDITOR.]

OCTOBER

THE COMPOSITE NATURE OF FRUITS; RELATIVE AMOUNTS OF CONSTITUENTS; PROPERTIES OF THESE CONSTITUENTS

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Compare different ripe fruits as to general proportion of water (juice) present. Dry the fruits; note loss of moisture.	See First Grade. Preservation of fruits and vegetables; first, as begun in the gathering, packing, and transportation of fruit. Conditions presenting decay and fermentation.	Constituents of fruit or plants: water, organic solid, ash. Note relation of ash in fruits with that part of the soil that will not burn. Determine the presence of water in the soil. Trace a fruit from growing place to consumer; note method of preservation. Plants: parts, functions. Evaporation as a means of preservation.	Fruits and vegetables; constituents. Sugar: presence in fruits and vegetables as a preservative. Relation of soil constituency to growth. Temperature relations to growth. Thermometer.	Plant growth: conditions of. Study of plant fiber: action of *acid* and alkali upon fibers (dyeing). Canning of fruit: conditions. Vinegar from apples: formation of acid. *Acid* and *alkali* tests.	Preservation of fruits and vegetables: salt, spice, heat, sugar. Preparations for change in season: by plants, in light of chemical change.	Seed formation: result of chemical change. Rise of industries. Common metallic elements. Cu, Ag, Au, Fe, Pb; occurrence, properties, compounds, metallurgy, uses. Continue in November.	Changes in vegetable life: result of chemical change. Weather observation: barometer.

NOVEMBER

CHEMICAL CHANGE SEEN IN DECAY (VEGETABLE AND ANIMAL); RELATION TO PHYSICAL CHANGE; CONDITIONS OF DECAY

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Conditions of decay: means of preservation by nature; by man.	Weather observation; effect of frost in decay. Temperature below surface of ground several feet; value of this fact in preventing decay in hibernation. Grains: kinds. Flours: kinds. Properties of different products of wheat grains.	See Second Grade for first half of outline. Constituents of soil. Metals: Cu, Fe, Pb; where found; mining; melting; casting. Continued in December.	Swamps: how formed. Constituents of soils in general: formation of. Clay beds: formation of; Use of clay in brick; the making of bricks.	Milling of flour. Chemical properties of milled products. Soap making; action of *acid* upon *alkali*. Properties of resulting salts. Term: *neutralization*.	Product of fermentation: CO_2; experiment. Yeast: effect of temperature upon; yeast under microscope. Vinegar making. CO_2 a product of direct chemical action, as in baking powders.	Make and identify O and CO_2. Respiration $\rightarrow CO_2$; decay $\rightarrow CO_2$; chemical compounds $\rightarrow CO_2$ (baking powder). Substitutes in cooking, for baking-powder, as molasses (if acid) and soda; sour milk and soda.	

DECEMBER

LIBERATION OF ENERGY; RESULTING FROM CHEMICAL CHANGE; OXYGEN

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Butter-making: constituents of milk; properties of fat; steps in butter-making. Making of flour: wheat ground in schoolroom. Compare the properties of fine, white, final product with coarser intermediate product as to thickening properties, etc.	Butter: see First Grade. Primitive methods of churning. Flour: continued from November.	Starch: vegetables used as source of supply. By experiment make starch; cooking temperature of starch; properties; test for presence of.	Combustion giving rise to heat and light; combustible materials. Resulting product of combustion, CO_2, compared with breath. Necessity of oxygen for combustion.	Making candles: primative, modern. Fats used: wicks, snuffers. Structure of flame. Products of combustion in candle flame. See *necessity* of oxygen.	Heat the result of chemical change. Various methods for the production of heat. Heating of houses—methods. Lighting of houses. Light the result of chemical change. Compare primitive with modern methods; relative values.	Respiration: relation to body heat. Ventilation: necessity for—principles of—	

JANUARY

FOOD PRINCIPLES; PROPERTIES; TESTS

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Continue work outlined for December. In cooking the fruits dried in the fall, note the large quantity of water required for cooking; compare by cooking fresh fruit of the same class.	Soils: note the comparative amounts of organic matter present; note moisture in different soils.	Constituents of flour: test for starch; separate gluten. Starch under microscope. Effect of high heat upon starch; e. g., sweetened crust of bread.	Extract starch from vegetables; test vegetables for starch; properties of starch. Gluten in flour a proteid. Egg-albumen a proteid. Cooking temperature of proteids. Sugar: kinds, distribution, manufacture of, use.	Starchy foods: value. *Solubility* of starch; effect of heat upon starch; of moist heat, dry heat. *Solubility* of egg-albumen. Effect of heat. Gluten in flour; value in bread-making.	Conversion of starch into sugar. Albumenoid in milk, compared with egg-albumen; how coagulation is effected.	Starch: structure of grain. Compare carbohydrates and proteids as to food value. Dietary studies: rough food analyses.	

FEBRUARY

CARBON: SOURCE, FORMS; CARBON-DIOXIDE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Fuel on farm; fuel used in city. *Thermometer:* the reading of; read the freezing-point.	Fuels in primitive life: turf, wood, etc.; compare with fuel of today.	Combustible materials. Incombustible materials. Preservation of meats and fish a winter industry as well; preservation by salt, smoke, drying.	Systems of heating: relative values. Heat transmission: methods. Metals: smelting.	Presence of *carbon* in all combustible substances. Review: candle dipping; comparison of flame. Alloys: making of; those suitable for dishes.	Forms of carbon: sources and uses of CO_2	Combustion defined in broad sense. Use of matches: sulphur match, lucifer match, phosphorous match. Phosphorous: (1) properties, (2) kinds. Principle of safety mach. Gaseous product of drawing match	Heating, lighting, ventilation of the modern house.

MARCH

COMBINATION (OXIDATION), CONDITIONS OF; KINDS OF; FLAME STRUCTURE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Conditions of combustion—general. Recognize a few of the materials (substances that will not burn).	Review February outline. Combustible materials. Conditions of combustion.		Old methods of "starting" a fire: flint, steel, tinder. (Sacredness of hearth.) Relation of heating system to system of ventilation.	Structure of flame: necessity of oxygen. Conditions under which plants grow; hotbed. Decaying matter generates heat.		Sources and uses of CO_2.	

APRIL

WATER: SOURCES, PROPERTIES (CHEMICAL AND PHYSICAL), PURIFICATION

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Forms of water: rain, melted snow and ice. Experiments in germination of plants; needs of plants.	Compare "city" water and "well" water with that obtained as rain, melted ice, snow, etc. Needs of plants. Try the different soils in January study; how do they meet the needs of plants?	Sources of water; properties of "hard" and "soft" water. Something in the one requires the use of more soap.	Sources of water: (1) conveyance, (2) properties, (3) characteristics. Purification: by distillation, filtration. Drainage.	Forms of water. value of soap in using "hard" water. Soap-making reviewed. Distinguish "hard" and "soft" soaps.	Water: boiling point, freezing point. Fahrenheit and Centigrade. Needs of plants. *Nitrogen* supplied by some.	Action of certain metals upon water. Sodium — + water; sodium hydroxide; + hydrogen. Note alkalinity; NaOH formed. Collect and test *hydrogen*.	Form in which water occurs in substances: (1) water of crystallization (alum); (2) integral part of substance (sugar); (3) water inclosed between crystals, salt. Use of terms, hygroscopic effervescent, etc.

Maple sap: boil to obtain sugar.

Evaporation: Power of chemical change in tree; building up sugar.

Dissolve much sugar; note consequent hardening in solution.

MAY

ATMOSPHERE: COMPOSITION; AFFECTED BY RESPIRATION, HENCE VENTILATION; PRESENCE OF MOISTURE; PRESSURE; TEMPERATURE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Reading thermometer.	Composition of atmosphere very variable. Discover the presence of water, dust, gases in air.	Relation of plants to soil, light, and air. Experiments indicating the result if either in insufficient quantity or quality.	Relation of plants to soil.	Weight of air; constituents of air. Determine roughly the relative proportion of these constituents.	Air in room, in upper and lower part. As result: what import in ventilation? Devise system of ventilation. Necessity of pure air for blood.	*Analysis of air:* Burn phosphorus in inclosed space. Remaining gas does not support combustion; is not O, not CO_2, but ***nitrogen***. Determine relative proportions of CO_2, N, and O, and moisture in the air.	

JUNE

ELECTRICITY; RESULT OF CHEMICAL CHANGE; EXPERIMENTS IN GENERATING ELECTRICITY

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
						Make an electric battery; principles of; magnets, magnetism.	

Proper understanding of chemical terms. All of outline illustrated and worked out experimentally.

CORRELATION OF MATHEMATICS AND SCIENCE[1]

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A foreword in regard to the point of view of this paper may be of service. I take it that any interplay between the school courses in different subjects to be of lasting value must spring from underlying relations which serve as essential links binding those subjects into one. This interplay must result in mutual helpfulness, or else it fails of its purpose. Science is not to be lugged into mathematics as an outsider, nor is mathematics to be foisted upon science as an added burden. If it can be found that the one is indispensable to the other, then and only then can there be any reasonableness in the remarks offered in this paper. I trust that you will find the position of the speaker a thousand miles removed from that of the teacher in a grammar school of a decade or two ago, who, holding up a bird before her bright-eyed pupils, asked them to count its eyes, its legs, its toes, its wings, etc.; and then propounded these elucidating questions: "How many eyes and toes does the birdie have? If it had three more toes, how many would it have in all? If you multiply the number of its eyes by the number of its toes, what would the result be?"

From the point of view of the scientist, mathematics is a tool of science; from the point of view of the mathematician, science is a field for the application of mathematical truth; from the viewpoint of both, mathematics is a method of science. In fact, it may be called the ultimate method of science; the more perfectly a science is developed, the more mathematical does it become, until it reaches a stage when it is classified as mathematics. Away in the past was it when the sciences of arithmetic and geometry assumed their mathematical names. In comparatively recent years mechanics has reached this same development,

[1] Paper read before the Department of Science Instruction of the National Educational Association,, Asbury Park, N. J., July, 1905.

and is now classed as mathematics. The various branches of physical science, astronomy, meteorology, and chemistry are rapidly being subjugated by this method of exact investigation; while the biological, mental, and social sciences are still in a very unmathematical state of evolution. The method is of such power and value that it must itself be made the subject of investigation; its inner relations must be scrutinized, and the inevitability of its conclusions established on a firm basis. There has thus arisen the most wonderful and enthralling science of them all — that science which defies definition, for it transcends all limiting bounds; that science which rears unto itself in imagination a palace whose walls and turrets know not the limiting thraldom of time and space; the queen science of them all, abstract mathematics.

If this view of the relation of mathematics and science in general be true, then it would seem that there should be a corresponding intimacy between the courses offered in schools and colleges for instruction in these subjects. Of course, there is and always has been a certain degree of interplay between such courses; but the query obtrudes itself: Cannot a more vital and effective relation be maintained? It is easy to see that the study of mathematics is absolutely essential to anything but a very superficial knowledge of the sciences. Physical laws of action, the laws of chemical action, and the laws of the formation of crystals are derived from observed data and verified by the methods of the higher mathematics. It is the very language of science. To read Shakespeare, one needs to know the meaning and the use of words. To read Hilton's *Chrystallography,* Preston's *Theory of Light,* or the works of the masters in chemistry, a very considerable acquaintance with mathematics is a prerequisite, if they are not to be sealed books.

But it is not to the scientific man alone that mathematics is indispensable; the engineering profession, that vast army of workers in applied science, is equally in need of such knowledge.

The minute differentiation of the engineering profession which has in very recent times resulted in the separation of the countless pursuits which require technical education, has opened an ever-

increasing field for the operation of human activities. The specialists who concern themselves with problems of sanitation, water supply, highway construction, marine architecture, bridge-building, the telephone, tannery, refinery, and manufactory, the machinist and the designer — all these, and a thousand more, call for expert technical knowledge. It is becoming more and more apparent that success in these technical professions is conditioned upon such knowledge and training. In a recent meeting of the National Association of Electrical Engineers it was the generally expressed conviction that one prerequisite for success in that profession is a thorough training in mathematics. It is clear that science is an indispensable part of modern civilization. Of course, science is not the only element in education, for culture is broader and must include much more. And yet it is certainly true that when so large a part of modern human activity is based upon scientific knowledge, it becomes necessary that the schools furnish ample opportunity for adequate instruction in science. I here use the word "science" to include both natural and mathematical science.

An examination into the teaching of science in the schools and colleges of America for the past two hundred years or so reveals some interesting things. Until very recently the study of science was considered of little importance. The amount of mathematics required in courses in astronomy and natural philosophy in early American times can be inferred from the amount of mathematics taught. At Harvard in 1643 the mathematical course began in the senior year, and consisted of arithmetic, geometry, and astronomy. The science of algebra was unknown on the continent. The importance ascribed to mathematics is shown by the time devoted to different studies: philosophy, 10 hours; Greek, 6; rhetoric, 6; oriental languages, 4; mathematics, 2.

In 1726 natural philosophy was given in the junior year, but was metaphysical rather than mathematical in form; nor could it be otherwise, as arithmetic and geometry were still taught in the senior year. By 1742 algebra was taught at Yale, and the mathematical studies were put earlier in the course. The freshmen had arithmetic and algebra; the sophomores, geometry; the juniors,

mathematics (probably trigonometry), conic sections, and natural philosophy. By 1766 fluxions had been introduced as an optional study.

Since 1816 the whole of arithmetic has been required for entrance to Harvard. The catalogue of 1825 adds algebra through simple equations, with roots, powers, and the progressions. In 1843 a little introductory geometry was added. The mathematical course at Harvard in 1818 was as follows: freshmen — algebra and geometry; sophomores — algebra and trigonometry, with application to heights and distances and navigation; juniors — natural philosophy, astronomy, mensuration of surfaces and solids, surveying; seniors — conic sections, spherical geometry.

The physics taught in the colleges of the eighteenth century required very little knowledge of mathematics. To master Olmsted's *Natural Philosophy,* which was extensively used during the middle of the nineteenth century, a fair knowledge of algebra and geometry, with a very little trigonometry, was sufficient. Almost no mathematics was used in the treatment of heat and electricity, whereas now calculus is commonly used in college courses in physics. In former days, when the college course (classical) chiefly trained for the so-called learned professions, the student found very little or no field in which his mathematics was needed. There was no application for it in his serious work, and it was therefore studied purely for a cultural value, as a means of training the general logical and reasoning powers of the mind. But with the growth of scientific study, and the rise of scientific courses and technical schools, the study of mathematics has assumed a much more important rôle. It now becomes an essential prerequisite to the future work of a large number of students; it becomes highly functional rather than decorative or gymnastic. We begin to learn that the real worth of mathematical study is not the general training of the mind, but the training of the mind in mathematical thought, to the end that our ignorance of the phenomena about us may be lessened and our impotence in the face of the forces which surround us may be reduced.

One would naturally suppose that such an important change

in function ought to have considerable influence in determining the form in which mathematics is presented to the student. It is having some effect in the dethronement of the mathematical fetish; the increasing tendency to make mathematical study optional is traceable, I think, in some degree to this cause. And yet the courses themselves are too little affected. In most cases the vital connection between mathematics and science is not dwelt upon, and the student fails to find any place for his mathematics in his scheme of life. He learns to cipher, but sees in it nothing but an artificial pastime. Now, ciphering is of value when ciphering leads to some desired end. The ability to solve a quadratic equation in itself is worthless; it is only when the equation is solved for some other end that the ability to solve it has meaning.

It appears to be true that under present conditions the student is not properly prepared in mathematics for his work in science. A training which does not furnish the student with the best and most efficient mathematical equipment for such work is certainly misdirected. It would seem to me that the statement just made must be acceded to, no matter what view is taken as to the end of mathematical study in the school. This brings us to the main question of this paper: How can courses in mathematics be organized to better meet the needs of science?

A speaker in a recent convention of electrical engineers said: "What we need most is a common-sense mathematics." This voices what seems to me to be an imperative need. We need a mathematics stripped of its artificialities and direct in its purpose. It is often a far cry from the mathematics of the schools to the mathematics of actuality. Our texts are filled with cunningly devised exercises which are remarkable for nothing but their intricacy, tangles, and labyrinths, the like of which are found nowhere save in the brain of the drill-master. They are meaningless devices, "which," to use Beltrami's language, "make the student's mind sterile through the everlasting exercises which are of no use except to produce a new Arcadia where indolence is veiled under the form of useless activity."

Such artificial exercises, it is true, afford a certain training, but a training in nothing else than dexterity in the manipulation

of impossible formulæ — "brain-spinning" as the Germans call it. Now, although a high degree of dexterity in the use of algebraic forms is essential to successful study of higher mathematics and science, yet that dexterity is not the main thing to be sought. That which is of the most importance in mathematics as well as in science is the interpretation of the mathematical forms used. In the higher mathematics there are countless forms that do appear and call for transformation or simplification. Let such forms be used as exercises in lower reaches of algebra, instead of the useless forms so prevalent in our texts. A few illustrations may make clearer this distinction between mathematics as it is taught and mathematics as it is used.

A recently published algebra tells us that "an unknown quantity is usually denoted by one of the last letters of the alphabet, as x, y, z." Now, this is far from being the fact, unless you restrict the field to elementary algebra. Open any book on astronomy, physics, chemistry, meteorology, or higher mathematics, and the exact contrary is found to be the case. Such equations as these meet the eye on every page:

$$\frac{a}{b} = \frac{\sin A}{\sin B} .$$

$$A = \pi r^2 ;$$

$$s = vt - \frac{1}{2} gt^2 ;$$

$$c = \frac{E}{r + R} ;$$

$$p = ae ;$$

$$w = c \log \frac{v_2}{v_1} ;$$

$$v = e^{ay + Bx} ;$$

$$I = \int p^2 dM .$$

In fact, in the higher mathematics x and y have a meaning largely restricted to the Cartesian co-ordinates. The constant use of the x, y method is harmful in that it relieves the student of the necessity of scanning an equation, for the unknown for which the equation is to be solved is at once recognized, and the solution

follows mechanically; whereas some attention must be given to such an equation as

$$D = \frac{w}{v} \quad \text{or} \quad s = vt - \frac{1}{2}gt^2 .$$

And right here lies a fundamental of great importance. From the standpoint of science, an equation is looked upon as stating a relation between certain numbers of co-ordinate importance. The significance of the equation rests in this, that if some of these numbers be known, the others can be found. Now, in order that algebraic training shall be of advantage to the student of science, this view should be firmly impressed upon him. Too often the equation is regarded as a formal puzzle to be solved, rather than an essential relation to be perceived. It is in the interpretation of the equation and the result of its solution that true algebraic thought resides. It were better to solve a limited number of equations understandingly than a large number mechanically. Nor will this thorough consideration of a few examples prevent the acquiring of dexterity in solution. For if all steps are understood to have a meaning, and are thoroughly mastered in their relations, the very clearness of perception thus produced will induce a better performance. Clear seeing is more than half in the doing.

Again, the scholastic method so prominent in all our texts produces the result pointed out by a recent scientific writer: "The regular textbooks of mathematics rather perplex than assist the chemical student who seeks a short road to a working knowledge of higher mathematics." The scientific student needs a thorough insight into mathematical methods, as well as a working knowledge of them; but to obtain this it is not necessary for him to go through all the artificial rubbish with which so many works are incumbered. A man can gain his exercise and develop his mathematical muscle among the green fields and wooded lanes of God's universe, rather than on the tread-wheel in a man-made gymnasium. I protest against a condition of affairs because of which it is possible to say that instruction in mathematics befogs the issue and cheats the scientific student out of the very results for which he began his study of mathematics.

As a second element in the improvement of mathematical training, I would suggest that the best mathematical methods be used as early as possible. As mathematical science advances, it produces better and better methods for solving given problems. It was a long step in advance when multiplication was substituted for a large class of additions; and one can hardly express the debt the world owes to Napier and Briggs for logarithms. Descartes, Newton, and Leibnitz have forged for us titanic instruments with which to work. The progress of civilization is conditioned to some extent upon the application of these discoveries to the needs of mankind. Without a murmur, the most of us replace our tallow dip with the incandescent fiber, the messenger post with the copper wire, the copper wire with the wireless telegraph. But there is a great outcry when any of us propose to use logarithms in arithmetic, trigonometry in geometry, or calculus in the secondary school. I even know of a college professor of mathematics who lives in a world long since outgrown, for, as he says: "Long ago I discarded from my teaching the doctrine of negative numbers." But the history of mathematics is but the story of the victorious march of new and better methods: new ideas and processes replace the old. New discoveries increase efficiency. A search in the algebras of a generation ago would not reveal the presence of the remainder theorem, the graph, or the determinant. Only within late years has the ratio definition of the trigonometric functions become current in our teaching. It is a waste of time and of perspicuity to teach simultaneous equations without graphs and determinants, or the geometry of the triangle without trigonometric functions. The calculus offers instant relief among the antiquities of college algebra and analytic geometry. Says Professor Jules Tannery, of the École Normale Supérieure, in speaking of the use of integral calculus in the secondary school: "After these lessons, say, nine or ten, one half-hour is sufficient to establish the expressions for all the volumes of elementary geometry." Why not use the best instruments the mathematician can turn out, at the first opportunity that offers? Says one, because the student cannot understand all the fundamental theory of the subject; especially is this urged in the case of calculus. But would you

throw the equation out of algebra because it is impossible to prove to the child that every rational, integral equation has a root? Shall we give up multiplication because we cannot construct a definition that will include all cases of multiplication? Indeed, we never get to the bottom of anything. What is number? No one can tell us, not even Professor Peano. We are often led away by that will-o'-the-wisp, thoroughness, until we lose our pupils in the maze and perplexities of the more advanced reaches of a subject much too abstract to be within their powers of comprehension; whereas the beginnings of trigonometry, analytics, calculus, and differential equations open a field of clear and simple ideas, well within their power of understanding. It is folly to insist that a problem be worked by a certain method of elementary arithmetic, when it can be done in a better way by algebra or calculus. It is high time to strike off such shackles as those with which Euclid bound elementary geometry, the ruler, and the compass.

The sciences — astronomy, physics, chemistry, and mechanics — can make powerful use of these higher forms of tools. What waste of effort to treat the composition and resolution of forces without the help of the trigonometric functions! The ideas of differentiation and integration are wonderfully productive in the hands of science. We can best benefit the student of science by giving him an early mastery of these powerful agents. He must have that mastery if he is to have anything but a superficial glimpse of the fields of science, or if he is to be of material service in the application of that science to the subjugation of the world.

But there is a third way in which mathematical course may better fit for service — the consideration of real scientific problems. The stating of a problem in algebraic form, its solution, and the interpretation of the result is rightly regarded a valuable part of algebraic study. All our algebras contain long lists of such problems, and it is to the character of these problems that I wish to call attention. They are for the most part manufactured, unnatural. A few illustrations, taken from an algebra published in 1904, will serve to make this point clearer: "A lady purchased 20 yards of one kind of cloth, and 50 yards of another, for $30. She could have purchased 30 yards of the first kind and 20 yards

of the second for $23. What was the price of each?" This is artificial, as no lady would ever meet such a problem. Or this: "A fishing-rod consists of two parts. The length of the upper part is 5-7 that of the lower part. The sum of 9 times the length of the upper part and 13 times the lower part exceeds 11 times the length of the whole rod by 36 inches. Find the length of the rod." This was evidently manufactured for consumption in simultaneous equations. It is thoroughly unnatural and impossible, and is a mere rehabiting of that old problem supposed to have been given by Euclid in 300 B. C.: "A horse and a donkey, laden with corn, were walking together. The horse said to the donkey: 'If you gave me one measure of corn, I should carry twice as much as you, but if I gave you one, we should carry equal burdens.' Tell me their burdens, O most learned master of geometry." As a contrast to these problems consider two. "A stone dropped from a balloon rising at the rate of 32 feet a second reaches the ground in 17 seconds. How high above the ground was the balloon when the stone was dropped?" "It is desired to find the height of a town or hill above a level plane. A 6-foot pole is set up, and the point determined where the line connecting the tops of the town and pole strikes the ground. The pole is used at this point, and a second point determined in the same way. The distance between these two points is measured. What is the height of the town?"

Objection is often made to this sort of a problem, that it brings in matter that is unfamiliar to the pupil, and it is said that in the first class, such as deal with ages, money, capital, partnership, legacies, "there is an especial advantage in that the attention is not distracted from the algebraic side of the problem while the acquaintance with algebra is as yet slight." After considerable experience in using both kinds, I find that students will solve the second class as readily as the first kind. They may require more thought, but this is to be commended; for the thought is productive thought. Respect for mathematics can hardly be maintained if its interpretation is given in terms of how old is Ann, and if it seems to have no more serious purpose than the solution of a mathematical rebus. It were much better to

present the dignity of a mathematics evolved to solve real problems; and the world is full of such problems — problems of number, mensuration, statics, and dynamics, which need offer no distracting ideas. The two problems just mentioned, the balloon and the town problems, were solved with little difficulty by a class in first-year algebra, and several solutions were given. These natural, real, vital problems should be spread through the whole course of school and college mathematics. I cannot refrain from quoting a rather humorous problem found by my calculus class. The problem was no doubt an attempt to be practical: "A train starting from a station has after t hours a speed of $t^3 - 21\ t^2 + 80\ t$ miles per hour. Find its distance from the station; time when it repassed the station; the distance the train had traveled when it passed the station the last time. The train passed the station after starting the first time at the rate of 1,200 miles an hour."

Mathematics is an abstract science. Its glory is that it can proceed to the profoundest generalizations without appeal to the world of the senses; and yet its ideas at the start are abstractions from that world. From one point of view, geometry is a system of logic entirely independent of a physical world; yet our Euclidean geometry is but a classification of observed facts and the generalization arising therefrom. The difficulties of a geometrical proposition may often be dissipated by the study of a model. In our geometrical teaching we are making constant use of diagram and model. The transit has come to be of service for furnishing material for the class in trigonometry to work upon. But this is about the extent of any appeal to the world of the senses, made in our classes in mathematics. To me this seems unfortunate, especially in view of the steady pressure by which mathematical study is being crowded into the earlier years of a student's growth. It appears to be undeniable that capacity for abstract thought develops late. Now, it takes thirty-six or forty-eight weeks to cover the same ground that was covered in twelve or sixteen weeks when geometry was a college study. Although we have lengthened the time for the boy, we have made but little alteration in the method, forgetful of the fact that "boys are not men of a

lesser growth." Boys are men in the process of making, and there the likeness ends. The impetus given to the study of physical, chemical, and biological phenomena by the recourse to actual observation and experiment has been most remarkable. It would seem to me that a similar vitalizing movement may be of service to mathematics. There are dangers connected with the use of experimental methods in instruction, and laboratory work has often been carried to absurd lengths; and yet the study of the world at first hand can never cease to be the fountain-head of all serious study. I firmly believe that the study of mathematical relations in concrete form by students of elementary mathematics is of great value. Last fall I asked a class beginning algebra to cut from a strip of cardboard 10 by 1½ inches a piece containing 12 square inches. Not more than two out of a class of thirty could do it. I found that very few of them had ever used a scale or a tape-line. All of them could answer the abstract question: "The area of a triangle is 15 square inches; one side is 3½ inches; what is the other side?" The divorce between the abstract and the concrete had been so complete in their case that the connection had been entirely lost. This is but an instance of a widespread condition — the failure to embody mathematics.

As a fourth means of meeting the needs of a scientific age, then, I would make the suggestion that more use of actual experiment and observation be made in our classes in mathematics. You will pardon a reference to some work with which I am intimately connected. I make it with the thought that a bit of testimony from actual experience may be of service in this connection. In Bradley Polytechnic Institute we have introduced such experimental work to a greater or less degree for five or six years. The results lead us to increase rather than diminish such work. There are certain experiments usually performed in the physics laboratory that are really mathematical in form. But little physical knowledge is needed for their performance. A number of these are now performed in our mathematical classes; credit is given for reports upon them by both the departments of mathematics and physics. It is not so much the purpose to teach physics as to teach mathematics in a setting of physics. In the beginning

algebra class the balance and lever are used; observations on the movement of a street car are made. The law of falling bodies, $s = \frac{1}{2} gt^2$, is tested by a stone dropped from the tower. Heights and distances are calculated, and then actually measured. This gives confidence in mathematical processes and control in their application. In the second year, devoted especially to geometry, the work is a little more serious. Careful reports are required on about thirty experiments, chosen because of the geometrical ideas involved. Among these may be mentioned reflection of light and formation of images in plane mirrors, refraction of light by prism, composition and resolution of forces, and inclined plane involving use of trigonometric functions. The same care and accuracy that are demanded in the physics laboratory are insisted upon. From this kind of work the student gets a more real and intimate hold on the meaning of geometric and algebraic truth. It is often objected that there is a waste of time in such work; it is said that "the geometrical results can be arrived at more expeditiously in other ways." Is it not true, however, that the geometrical result is not the only thing to be sought. Fully as important is the setting, the value, and the utility of the fact. A boy may not see the use of filing a piece of metal to the exact diameter demanded by the teacher; but when he finds that the piece is too large or too small, by the thousandth of an inch, to fit into the engine or machine he is helping to build, and has to be made over or thrown away, he learns something of great value. Just so the student who finds that exceeding care must be taken if the lines determining the image in the mirror are actually to meet on his drawing, learns something from his own experience that the insistence of the teacher can seldom impart.

Our experience seems to point to two definite things. We are often told that, "no matter how geometry be taught, the student must be able to pass the entrance examinations set by the colleges and the universities." Now, while I demur to the view that the typical entrance examination is either a fair or a desirable test of mathematical ability, I am willing to admit that, since the examinations exist, they must be met. We determined to make a test in the examination just held two weeks ago. There were two

classes in geometry to be examined: One, a class of boys, was given the entrance examination for one of the large eastern universities; the other, a class of girls, was given an entrance examination of one of our best-known woman's colleges. The instructor in charge of the classes did not see the papers until they were given him at the time of the examination. The class had reviewed but a very small portion of the work of the year. There were in the classes a few students whose general standing as students would debar them from being college timber. Of those who were at all eligible for going up for college entrance, but two out of forty were unable to pass, and those two were good students who always fell down on examination from emotional or nervous reasons. Some of the papers were of a very high order. At least this can be said. After a training involving a large number of physical experiments, they were no less able to handle the reasoning of the abstract originals than are those who are not so trained, while at the same time they have in addition a real and intimate knowledge of mathematics as revealed in natural phenomena.

The other point of interest comes as testimony from the classes in physics. Said a boy who entered the physics class from another school, to his instructor in physics: "You talk to us as though you expected us to know mathematics, and I seem to be the only one that has very much difficulty in using mathematics." Now, this is a crucial test.

This is the real service that instruction in mathematics may render to science. Not that science be taught as science in classes of mathematics, but that the language in which science speaks shall be taught, and as far as possible mastered, so that the science teacher may proceed with his teaching unhampered by the inability of the student to understand the language in which he can most clearly and accurately put the ideas and laws with which he is dealing.

By such means it would seem to me possible to make mathematics a more efficient instrument in the hand of the student of science or engineering. Nor would the student who is to become the pure-mathematician receive a less worthy training. It is from a rich mathematical soil that the great mathematicians of the

future will arise. It is Fourier who said: "The deeper study of nature is the most fruitful source of mathematical study;" and we remember that it was the effort to solve some particular problem of science that gave birth to most of the great advances in mathematics. In our study of mathematics, the queen of science, let us not get too far from that world which, to quote Kelvin and Tait, "is replete with astonishing theorems of pure mathematics such as rarely fall to the lot of those mathematicians who confine themselves to pure analysis or geometry, instead of allowing themselves to be led into the rich and beautiful fields of mathematical truth which lie in the way of physical research."

A CONSIDERATION OF GEOGRAPHY TEXTS

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No other elementary textbook costs the publishers so much to make ready for the market as does the school geography; and none comes in for a greater share of abuse, by teachers and schoolmen generally. If the teaching force of the country really know what they want in this particular, they have never succeeded in making it clear. The criticisms in the main have been iconoclastic rather than suggestive. The present paper, while frankly stating a personal view-point, will attempt, in the end to contribute something on the constructive side.

DO WE NEED A TEXT AT ALL?

The belief is held by many educationists that if our grade teachers were properly equipped in training and scholarship, there would be no place for the textbook. We have set up, in our pedagogical shrine, an ideal teacher, of high conceptions, high attainments, and high mettle, to whom we conceive the textbook merely as an impediment, prescribed by an undiscerning superintendent.

That this is a dangerous fallacy, however, it requires but a glance over the situation to show. Not all initiative is dependable, and not all the roads of individuality lead to Rome. Our profession is full of people with crochets and hobbies, and perhaps you and I are among the number. Too many of us poke hairpins into the course of study, to see the wheels go round, or possibly to make them turn the other way. Occasionally there arises one who can blaze a new trail, but there are not many. For the rank and file of us tradition is by far the safest working platform; and with it under our feet we in the long run render our best service. So far as geography-teaching, at least, in concerned, no scheme superseding the textbook has ever been offered which has proven,

in the estimate of schoolmen at large, acceptably inclusive and exclusive.

The textbook appears needful also for a diametrically opposite reason. It not only answers as a corrective against crochets and distorted perspective, but, on the other hand, it sustains, in a fair degree of continuity, the work of the great army of teachers who are troubled neither with crochets nor perspective. In a word, it is the only safeguard we have against the chaos of genius, on the one hand, and the barren wastes of indifference, on the other. Those upon whom devolves the task of shaping the materia and methods of elementary teaching must ever be conscious that they are purveyors, not to a few geniuses and zealots, but to a great body of average toilers, tolerably alike, and numbering, in our own country, nearly four hundred thousand head. Viewed in this practical light, the textbook, be its failings what they may, appears as a veritable life-buoy in the deep.

THE CHARACTER OF EXISTING TEXTS

A painstaking examination of all the school geographies now offered for sale leads to the conclusion that, in a large way, all geography texts are the same texts. The authors have been too respectful of tradition to launch out into any marked deviations looking to a radical improvement in geography-teaching. Notwithstanding the broad claims of each new prospectus, all of the contemporary texts (with the two exceptions noted[1]), together with their predecessors for the past seventy-five years, are seen to be virtually repetitions, one of the next. There is a relieving variation in cover design and preface, but there the differences virtually stop short. Indeed, there are certainly six contemporary geographies (three by the same house) which are so nearly identical in plan and content as utterly to nonplus the superintendent who would choose a text. Only the publishers themselves could supply the reason for this duplication.

This pervading likeness greatly facilitates comparison. Taking them as they stand, there would seem to be five particulars upon which to base a choice among the current texts. These are

[1] The Tarr and McMurry series is a partial, and the Chisholm and Leete scheme a complete, exception to this statement, as later noted.

(1) make-up, (2) maps, (3) illustrations, (4) content, (5) method.

1. *Make-up.*— The claims made for the novel make-up of the Tarr and McMurry geographies are in part justified. The reduced size[2] proves a convenience, and a test of two years' wear and tear in the schoolroom shows these books to have a superior endurance. The one point in which the small page is at a disadvantage lies in the impaired value of the maps, despite the claims made to the contrary.

A more important matter, in which the Tarr and McMurry series scores an advantage is the psychology of the printed page. Certainly the most serious criticism to be made upon textbook make-up is the confused medley which the usual page presents to the reader's baffled eye. Opening a Redway at random (and it might as readily be a Frye, Butler, Morton, Roddy, or other), I find (p. 86) five fonts of letters disposed in a very mêlée of typography, and located in odd nooks amid the jumble of illustrations. This page is quite typical of those in any of the large-form geographies. The Tarr and McMurry books also yield to this fondness for kaleidoscopic type effects, but the small page and single column make the results less disastrous to the reader's concentration.

Finally, the table of contents is as available in the Tarr and McMurry as it has always been unavailable in other texts.

2. *Maps.*— With regard to political maps it is argued that the standard reference maps of the old-line textbooks are unduly crowded with names of unimportant towns, provinces, etc., which are not germane to the content of the geography lesson, and therefore serve only to complicate the map without rendering any return service; and that by a wholesale elimination of these cartographic minutiæ a result is attained which better serves the end in view. It is worthy of consideration, however, that in the typical schoolroom the text geography must serve also as an atlas, whenever an atlas becomes necessary. All the geographical references arising in the history lesson, the literature lesson, and

[2] A reversion to Jedidiah Morse, whose excellent geography flourished a century ago.

the daily news must have recourse to this book, in default of a more richly informational source. We have then to decide whether the extreme denudation of the political map is of sufficient import, psychologically, to offset its diminished value for purposes of general reference.

A comparison of leading texts suggests that in the Tarr and McMurry series this elimination has been too sweeping, and that the maps are thereby lessened in usefulness. It is true that the detail maps make up for the omissions in the continents. But it is a matter of much importance to locate a given feature upon the map in hand instead of searching further for it. Some of the other texts have been a trifle more conservative in this matter of eliminations, and the result is in their favor.

Whatever may be the decision upon this point, there is another which must not be confused with it. After having determined just how far the simplifying of the political map is advisable, we must not, in the same act, denude the physical map of what at first thought may be set down as worthless details. I refer to minor lakes and rivers, descriptive elevations, and deviations of coast-line. Unfortunately, a theory has gained some foothold that by robbing a map of its descriptive coast-lines, and by omitting the unnameworthy but richly descriptive small rivers, lakes, and minor relief, we have served some pedagogical principle. By the same logic we should have to expunge the stars from the firmament, that the pupil might with greater facility locate and identify the moon.

Of the texts examined, Morton's on the whole, has the most desirable maps. To begin with, each continent is introduced by a full-page physical map, followed by a political map with the physical features underlying. This initial separateness of the physical map is of some moment in a step-by-step, or cumulative, plan of teaching. Also in Morton the physical maps have a more realistic relief than those of any other text. These maps use the pictorial, or light-and-shade, device for mountains with a surpassing effect. It is used also by the Tarr and McMurry, but with less success. In the latter its quality varies from the moderately effective relief in Fig. 177, First Book, to a faint and unde-

scriptive stain in Fig. 183. Compare either with Morton. The Howell reliefs, for which much is claimed in the Tarr and McMurry, are fraught with significance to the tutored eye of the physiographer, but they are utterly without grasp on the imagination of the child. The Howell marine relief, p. 2, Second Book, is an example of a (to the child) quite meaningless and uninviting illustration.

Maps for school children should afford some sort of transition from simon-pure pictures to the aggregations of symbols which carry a message to the eye of the physiographer or engineer. Redway's maps use the hachure symbol for mountains, and his relief, while valuable reference for the teacher, is unintelligible to any but mature students. The black-and-white reliefs of Frye vary from the mechanically effective United States on p. 68 to the unspeakable creations in the Supplement, pp. ii–iv. But even the best of these reproductions from photographs of wax or putty models are very barren of that genuine suggestion of a teeming area of land. Structural models have scant effect in stimulating the child's imagery, and photographs of the same must have even less. These black-and-white reliefs can be given a superlative value, however, if they are *drawn,* thus receiving the suggestive touch of the artist's hand.

Frye's political maps are superimposed over the old-fashioned hachure, or symbolic relief. His colored physical maps, are equal to Redway's, inferior to Morton's and smaller than either. The picture maps in Frye, however, are a very valuable revival of an old device, and will be considered later.

Compare[3] Morton, p. 48, with Frye, p. 65, or Redway, p. 44, or Tarr and McMurry, Second Book, p. 121. These Morton maps appear to be the most richly descriptive that have ever been produced. Compare Morton, p. 60, (New England), or p. 89 (California), with the corresponding maps in Redway, pp. 60, 88, or Frye, pp. 91, 117, or Tarr and McMurry, Second Book, pp. 124, 281. In the Tarr and McMurry the transition from the pictorially conceived earth through several intermediate stages to the detail maps of political areas is to be commended.

[3] In each case the advanced book.

3. *Illustrations.*— Since the legitimate use of pictures is to enhance the descriptive effect of the text, presumably the highest artistic skill will give the most richly descriptive illustration. But we have allowed ourselves to fall into the curious belief that the camera lens cannot lie; and that therefore the most direct product of photography is necessarily the most descriptive picture. On second thought, however, it is apparent that a photograph is, in the general rule, the least descriptive of all pictures; and that the half-toning process of reproduction is very apt to reduce its descriptive value still more. The photographic lens in average hands exercises no selective power; neither does it lay that intelligent stress upon the right spot which only the *bona fide* illustrator can secure. Pen-and-ink, woodcuts, and wash drawings cost more than reproduced photographs, but they are of incomparably greater descriptive value.

Redway's and Frye's geographies use woodcuts throughout. These pictures are satisfactorily descriptive. The Morton pictures are half-toned, but they are reproduced from drawings, not photographs, and the result is surprisingly brilliant and descriptive. On the whole, they are superior to Frye's and have something the advantage over Redway's.[4] But the animal and landscape picture-maps of Frye's are peculiar to that series and cannot be too highly indorsed, either as a teaching device or as to workmanship.[5]

The Tarr and McMurry illustrations are half-toned from photographs. Even with matchless workmanship, the outcome of this combination is always lacking in virility. But somewhere in the process the work has been ill-done, and the results are, in the main, muddy, dim, and undescriptive. These half-tone photos are without that piquancy of light-and-dark and atmosphere, which gives to woodcuts and pen-drawings their descriptive quality. Turning to p. 5, Tarr and McMurry, First Book, this distinction is clearly seen. Compare the pen-drawing, Fig. 4, with Fig. 3, on the page opposite. Or, compare the iceberg, on p. 193, with the icebergs in Redway, Advanced, p. 19, or the

[4] *Vide* "Gathering Cinchona," p. 114, Morton.

[5] See Frye, pp. 44 ff.

Elementary, p. 9; or Morton's Advanced, p. 24, or the Elementary, p. 69.

4. *Content.*— In the matters of arrangement and content, the Redway and Morton geographies are remarkably alike, and appear to have been built in a common mold. In the table below it will be seen that these two books give almost page for page the same attention to the various divisions of subject-matter. Frye elaborates considerably in the direction of physiography and United States. He is unduly scant on foreign *civilized* areas, notably other North America and Europe. Tarr and McMurry, on the contrary, while dealing more abundantly with all the divisions, are especially attentive to Europe; this is a point of considerable value in the latter book. It is the German policy to teach the young subjects of the Kaiser a great deal about the Fatherland and its dependencies, and as little as is convenient about the rest of the world. This inbreeding of the national ideal and ideas is observable in an even greater development in China. The true fruitage is slow in revealing itself, but it comes at last. It has come to China, and it will come to every nation that deliberately narrows the outlook of its school children. No geography course is justifiable which tends to emphasize rather than correct the provincialism which no community ever wholly escapes. We cannot afford to teach any geography that does not, in a generous sense, provide or imply a substitute for world-wide travel. Still, on the other hand, such instruction must not crowd a fairly intensive study of the home country. Considering the fact that the elementary school claims eight thousand hours of the pupil's life, there should be ample room for both.

During the latter part of the last century an avalanche of physiography descended upon the elementary school, from higher institutions, and invested its course of study. This has not influenced the textbooks, however, as much as might have been expected. The physiographic minutiæ of earth structure occupies ten pages of Frye's Advanced book and twenty of the Elementary; of Redway's, somewhat more in the Advanced, and considerably less in the Elementary. Morton's contains less than Frye's by half in the Advanced, and none at all in the Elementary.

Tarr and McMurry devote an equivalent of seven of the large pages to this material in their Second Book, and the first eighty pages in the First Book. But in the latter case the material is skilfully made local to the average child's experience, and each unit of thought is summarized in a pregnant sentence immediately following and printed in italics.

NUMBER OF PAGES DEVOTED TO EACH DIVISION

	General Geography and Principles	United States	Other North America	South America	Europe	Asia	Africa	Australia, etc.	Appendix
Redway	41	43	15	10	18	14	6	4	26
Morton	39	44	22	10	20	14	8	6	17
Frye	65	63	12	9	16	15	10	5	8
T. & McM. 2d and 3d books *	57	80	16	14	55	16	12	10	16
Roddy	19	42	14	10	20	14	9	7	4

* Figures corrected for difference in size of page.

5. *Method.*— There seems good reason to concur with Tarr and McMurry in their argument abandoning the uniform map scale — more particularly as no textbook has ever succeeded in maintaining such a scale. And, as someone has said, it should be a part of the pupil's training early to recognize and accept scale variation in maps, since in a multitude of his experiences he will encounter it.

The reaction from our late over-attention to physiography points toward an increased regard for descriptive geography, especially on the human side. The Tarr and McMurry books, by reason of their expansion, are the only series that can claim really to abandon the definition and desiccated statement and enter the task of description. The foregoing table discovers in the treatment of Europe a proportion of 55 to 16 in favor of Tarr and McMurry as against Frye. In spite of the more intensive treatment of the subject-matter, however, the Tarr and McMurry text is hardly less dry and didactic in its style than the others. It is descriptive in a purely informational way, but lacks the color and atmosphere which are a prime requisite in the best

geographical reading. A little more attention to the art of word-painting and a little less to the didactic ideal of causal relations would have lessened the necessity for supplementary reading.

The expedient summarizing of each topic is an important consideration. Of all the information imparted by the geography course, our expectation is that the pupil will forget the greater part. But in connection with each topic there is a nucleus, or generalized notion, which we hope he will remember. For the purpose of selecting from the topic this precipitate of essential matter, a topical summary is needful.

The Frye and Redway texts have come nearest to supplying this organic thing. Morton is wholly lacking in this respect, depending upon a fly-leaf suggestion (p. 4, Advanced, and another on p. 61) to fill the need. Tarr and McMurry have a valuable series of summaries in the First Book, but thereafter this plan is abandoned and no substitute furnished. The "Questions and Suggestions" are of great value as searching exploitations of the text, but they have no movement toward focusing upon a nucleus of essentials. The "Summary and Conclusion" appearing at the end of the Second Book, and substantially repeated at the close of the Third, is excellent, but too long delayed, and too remote from its immediate text to equal the value of an oft-recurring topical summary.

An important point in method is the treatment of characteristic, instead of political, areas in descriptive geography. The old-time textbook taught that Minnesota raises wheat; and as an entirely distinct and unrelated item the pupil memorized from another page that Dakota also raises wheat. Thus the simple organic units of description were chopped up into meaningless fragments by the "square-inch" method. Redway and Morton make a free use of this treatment still, contenting themselves with an exceedingly brief unifying survey at the opening of each areal study. Tarr and McMurry, on the contrary, make the areal treatment the substance of their scheme,[6] following it with a short square-inch treatment under the political headings. The necessary result is that in the one case the pupil's descriptive fund is received

[6] *Vide* Second Book, pp. 200–33; cf. Morton, pp. 81 ff., or Redway, pp. 80 ff.

in unorganized, unstable fragments that are soon lost to him; while in the other there is every reason to believe that he will retain an essential knowledge, organized and related in a few large, simple units.

Frye uses the areal treatment, but less intimately and intensively than do Tarr and McMurry.

In the Tarr and McMurry books the relation between physiographic processes and man's affairs is constantly brought to the pupil's attention. So much as a book alone may do in this direction appears here to have been accomplished; always excepting the photographic illustrations, which should be replaced by woodcuts or pen-drawings.

Having thus looked into existing texts upon their own grounds, it remains to consider in what respects and how radically the textbook of the future may profitably differ.

Those now in use fall into the fundamental error of trying to furnish a description of the earth and its inhabitants within the limits of a single volume. They are thus compelled to serve up their contents in a highly concentrated form. Their desiccated statements are at once barren of imagery for the pupil, and unwieldly as a course of study. In a high endeavor to be both a syllabus for the teacher and a book of content for the pupil, they fall short of achieving both aims. They are, in any real sense, neither textbooks nor descriptions; and they are not easily adapted to any known scheme of teaching. Our present question is, therefore, not as to whether the task, within its limits, has been well done, but whether, such as it is, it has ever been worth the doing.

The Tarr and McMurry *Geography* is a departure in that a determined — we may say heroic — effort has been made to expand the text into actual content. The result, while certainly an improvement, in the end simply goes to clinch the conclusion which was already obvious: that a satisfactory treatment of geography can never be compassed in one volume, be it never so bulky, and be it in one or several parts. The Tarr and McMurry series is a strenuous and thorough exploitation of a blind alley —

a blind alley into which competing texts entered and remained much nearer the entrance.

A *bona fide* geography text will have two essential parts; one of these an atlas, made up of maps and such tables of statistics as are needful in ordinary reference; the other, a minutely specific course of study, for the teacher's guidance. Then, in addition to this textbook, there will be added, in a complementary relation, a copious fund of geographical readings, such as fifty volumes could scarce include. Fortunately, this complementary material is to a great extent already at hand, in the splendid supply of geographical readers lately appearing. The list is far too large to enumerate here, but the Carpenter Readers and the Youths' Companion books are typical of the best. We must not, however, confuse these highly available books with the flood of juvenile adventure, which has the consistency only of foam, and leaves no precipitate.

The proposed textbook itself is seen in prototype in the Longman's Atlas, taken together with the Chisholm and Leete handbook. Unfortunately, these books, as a unit, have not been promoted by their publishers with the zeal which they merit. Considered in combination with the complementary reading above mentioned, they certainly appear to point out a happy solution of the vexed problem of geography-teaching, so far as books are involved at all.

THE PUBLIC SCHOOL AS A SOCIAL CENTER

OLIVE E. WESTON

There is no American institution that wields so great a power for good as the public school. By the public school is meant the elementary and high schools, including the kindergarten. This great institution is really the most democratic of all our democratic institutions. It is the cradle of the deepest principles that underlie our government and our religion. In its conception it is no respecter of persons. The highest and the lowest may share alike its beneficence. Fame and glory in the public school, if that school be not in the clutches of politics and politicians, come to the one, who within himself, holds the elements of success and of greatness. The rich is as good as the poor in the public school, if he does his part and plays fair. A clean, bright, honest little fellow from the poorest hut, may sit or stand beside the millionaire's son whom riches and love have surrounded with luxury and beauty. If the poor boy be industrious he may even put the other one to shame in their mutual tasks. On the other hand they may be equally skilful and great chums in the public school. The rich man's son will throw himself into the water to save a drowning companion, though he be poor and unlettered, if he be a schoolmate. As the sun in heaven shines upon all alike, so the true spirit of our public schools would shed equal benefits on all its children.

Look at our night schools. Go visit them. You will see fine buildings warmed and brilliantly lighted from roof to basement, and every room open. Enter and you will think you are in classic halls. You feel like taking off your hat and moving with light step, for here you are in a great community where no one is idle or unhappy. All are doing what they love to do. Here is a white-haired man studying chemistry. He never had a chance when he was young, although he evidently had a taste for it.

Here is a boy who works down town all day in a factory. He comes here at night to study electricity, so that he may learn to understand the power that runs the great machine he tends all day. But look farther. Here are young men and old, middle-aged business men, girls and women, all too busy to see you. All these may for the taking, gather the riches of knowledge and study the law of the universe, without money or price. This is the public school, and instructors come here to give out the best they have, at this banquet of mind.

I wonder if we thoroughly appreciate and rightly understand what this great public school system is doing for the future citizens of our city and our country. It is high time that we make use of our opportunity and acquaint ourselves with it in all its phases; for instance: Let us inquire, How did this come to be a free school? Who is responsible for its excellence, and who may be charged with its failures? What is its purpose, and what does it accomplish? What is its curriculum and who makes it? Where do the teachers come from? Who are they and how are they prepared for this great work? Who selects them and on what basis are they chosen? What are the essentials of a good teacher? What is the relation of teacher and pupil, or teacher and parent? What are the responsibilities of the home and the school in the education of the young? What should the school do for our children socially? What is it doing now for this essential part of their training? What can we, fathers and mothers, club members, and thinking men and women everywhere, do to bring this greatest institution of our land to its highest function? How may we co-operate, and with whom shall we co-operate?

These are some of the questions that we should study with great care, and with deepest interest; and then proceed to answer them by doing something. Every father and all mothers are needed right now to seriously undertake the solution of these and like problems. The great trouble is that parents do not know their children. Then how can they be expected to know their needs, or how to meet them?

The home is the first and primary institution for the study and development of the child; but the school is next and very

close to it. Out of the heart of nature comes the raw material for the making of God-like beings. The home is the womb, where the embryo statesman, philosopher, scientist, artist, or great teacher and leader are nurtured. When the seeds are sown and the budding begins, the child is transplanted to the school or kindergarten to be developed or dwarfed as the case may be. Who should know so well what that school should be, and what it is, as the parents? In the home the process of absorption has gone on; the child has gathered sense-impressions and experiences by the million, each leaving its effect upon the child somehow and somewhere. Here emotions of all kinds have been awakened for the first time, ideals have been forming, aspirations and ambitions have been aroused and ties have been fastened to the tender heart. Now he goes to the school to develop all these into usefulness or to have them changed or crushed and killed. In the home he has learned to co-operate, to be one of a social fellowship, to think of others while seeking his own happiness; and if the home be a true one, he will have learned that the good of all is the good of each. At home he had first an unconscious, then a subconscious, will. He goes to school to become conscious of his growing power, and in proportion to develop a conscious will, a new force, a directive force. At home he has been under the direction of others. In the new surroundings he feels a desire for self-direction and the direction of others. This is legitimate. It is a needed experience in forming the man who may be able to take a high place in the world where such power is needed. We are said to be made in the image of God. The truth is, we are making ourselves into the divine image, and if the child has half a chance he will do it. God created the universe and directs all its forces, seen and unseen. To be God-like, man must be a creative being and learn to direct the forces of nature. To do this he must understand the laws of the universe. Watch any child and you will see the expression of this divine nature. With the discovery of his powers comes the desire to use them. He wants to make something, to test and manipulate all the materials and forces within his environment. He feels that he is surrounded by many wonderful forces and he longs to discover

them. He wants to touch, handle, and name everything he sees. This is perfectly legitimate. It is God-given instinct. Now what do we do? Why, we are inclined until we learn better, to combat and suppress all these instincts and tendencies. We are forever saying to the child, "Don't touch," "Don't try to do this or that," "Don't go here or there." Is not this true? The child feels a precious individuality within himself and longs to assert his inheritance. He attempts to be self-directive and we head him off and assume the directive power, and so dwarf his being. When we send him to school, he feels anew this impulse, and at once gets into trouble, because some one else who does not understand the impulse is unable to respond to his needs. You say, "He should learn obedience." Yes, if you can show this thinking being the justice of it he will gladly learn it.

In the public school, the little ones find ways of physical development in their free play, and the social instincts are easily satisfied; but about the sixth grade a great change comes over the whole nature. Not a sudden change, however, but at the threshold of adolescence the demands of the child are greater physically and socially, if not mentally. The creative power asserts itself in a new way; life opens up to the boy or girl with an intensity, which, if not understood is alarming. Now the child begins in earnest to study the law of cause and effect and to inquire into the relations of life. He asks for his own origin and would become acquainted with processes and causes. He or she as the case may be, chooses some confidential companion who is in the same state of mind, and together they try to solve the mysteries of being. Often they gather about them others of their own age and sex in segregation; clubs and fraternities are formed, and the legitimate business of their lives, which is to know and understand themselves, is often carried on in an illegitimate way. Parents, teachers, and friends begin to worry and try by hook or by crook to overcome and circumvent all this business, while all the time the youth are fortifying themselves against every attack. They even resort to the law and combat the powers that be with their own weapons.

Now, parents and teachers, this is your business; your duty

unveils itself at this point. What is the trouble? Is it with the home or the school, or with both? First of all, I think the responsibility is with the parents, to see to it that each child should be informed, should be enlightened upon these vital and natural questions. If possible this knowledge should come through the parents by a mutual study of the life of plants and animals. Watching the habits and methods of a few plants in their round of germination, development and perfection for one or two seasons, carefully noting the effect of heredity and environment, would awaken a deeper reverence in the heart of the child than any amount of preaching would do. Here is the basis of this plea for practical nature-study in all the grades of the public school. If directed in the right way it cannot be done too early.

Watching the process of development of the seeds, bulbs and flowers, the child will meet many vital questions which should be answered with great care, but truthfully and in correct and scientific terms. In all cases the universal laws of nutrition, self-preservation, and reproduction, should be pointed out, and when the interest seems to center in any one direction, the emphasis should be placed there. Inch by inch, as it were, the truth of the law of all life will work its way into the child's mind and heart. It is this law that the child is consciously or unconsciously searching for. When the interest passes over to animal life and human life, do not hush it up, but follow the lead of the question and when you come to the conclusion say "All life comes in this way, from a seed, which is life's cradle." Then when once you have opened the door, you must prepare to give your very best interpretation of life, and you may have to go to your *Encyclopædia Britannica*, your Darwin, Spencer, and many other heavy books, that you may give the sacred truth. But give it, and without delay. Children will not wait; they are immediate and exacting. They instinctively feel that time is precious. We know it is, and yet we waste it. Children observe and know much more than we realize, but they get false ideas, and it often takes years to correct them. Let us start them out with the banner of truth. "Know thyself" is a divine injunction.

When the time comes for definite questions, there should be

a carefully prepared course of study on the origin and the methods and relations of life. Every boy and girl ought to study such a course with an expert teacher. Small groups of girls who are friends, and groups of boys in the same manner, with an earnest, gifted instructor might thus be given the key to high thinking and lead them to right living.

If our schools should have nature-study as an essential part of the curriculum for every grade from the kindergarten up, with planting, tending, observing, and studying, with first-hand experiment, and all under the guidance of a lover and student of nature, the problems that so vex parents and teachers now would nearly all be solved. We talk down to children too often. Let us turn our faces upward toward them and borrow a little of their enthusiasm. All other studies might better be neglected than this. How they like the words "biology, chemistry, zoölogy, science," and all the rest. I asked a ten-year-old what he was having in school that was fine. "Chemistry of foods," was the prompt reply and he proceeded to enlighten me on the sugar and starch found in certain vegetables. I was not surprised at this because I know that children are interested in things related to life in a practical way. So would they be deeply interested in civics as a practical study. Witness how they love to plant and tend and harvest the gardens; especially the vegetables that can be taken home and used. Children are eminently practical, and there is no doubt that they would order their lives to live in harmony with the laws of life if they had the knowledge needful. The fires of the passions that are often uncontrollable in the boy, or girl, or the youth, being once understood might be turned to great account.

Instead of being a misfortune the possession of this power may become a great blessing. It is a fact that all great art, all great achievement in any direction is simply the output of this creative element in human nature. It is this deep surging sexual passion turned to good account that moves the world. Think what harm the steam engine might do if it were not well understood and controlled. Electricity would send the world to destruction if it were not directed under the laws of the universe

by man's intelligence. Now this wonderful force which makes so much trouble and breaks so many hearts is nothing more or less than a great electric dynamo. Shall we, then, keep the child in ignorance, or shall we give him his birthright and enable him to use it for making his way Godward? But how may we know when to lead him to this fountain of knowledge? Watch your child. He will teach you. When you see the self-consciousness, self-assertion and awkwardness that comes to every child; when your boy throws out suspicions and pugilistic tendencies; when he forgets to give you the good-night kiss, then be sure he is well on the way. He feels the change within him, a welling of something he does not understand. He is petulant, seems less loving, and less thoughtful for others; less obedient to individual authority. He wants to be alone or to go out with the boys; or if a girl, she wants to go to stay all night with her best girl friend. If a boy, he scorns girls, while perhaps in the secret recesses of his heart he feels, somehow, a deeper interest in them; studies them more closely, judges them more severely; scorns and loves them at the same time. He fixes his ideal of a woman far above any one he knows; seems to care for girls older than himself. In a thousand ways he is unconsciously telling you what is happening, if only you are able to read this wonderful book of nature.

In the moods and new manifestations of the young girl, she also is revealing the dawn of her womanhood and the wise mother will read the demands of this enlarging soul. The paramount needs for both boy and girl at this time are social needs. More than one-third of their waking hours are spent away from home and usually in school. Now what is the school as a social center doing for the child? First, and above all things, the school should administer to the social needs of the children, for only as he is related to the world as a social being can the child hold any place as an adult. Society is a unity and can be no better than the units of which it is composed. Each must find his true relation and contribute his character and work to bring the whole to a perfect unity. The school belongs to the fathers and mothers, and it is their responsibility to make the schools just what they should be. They are supported by the people. They were made

for the children and are the legal ward of the state, but the parents are the natural guardians of the institution.

The public school was not established for a source of revenue, but for a commodity far higher, viz.: for the making of men and women, noble and useful citizens. The Board of Education, the superintendents, principals and teachers are all agents or employees of the people. And from this point of view it is clearly seen that it is the duty of the people to look after this work of education; to see that all investment of money, time, and thought is made wisely and to the greatest good of the greatest number. The returns must ultimately be measured in character and ability.

Let me urge that this question of the public schools, especially the high schools, is the burning question today. It is the most important and immediate duty of every man and woman in the United States, especially in Chicago, to guard and manage well this inheritance of the children now with us and the children yet to come.

The true function of the American public school is to educate the people. It is the poor man's college, a preparatory school for the university work, and a place for social culture for all. It belongs to the children and youth in the morning hours, it should be the center of club and community life of the mothers in the afternoons, and a school for the workingmen, and boys, and women, five evenings in the week, and a true neighborhood center for the balance of the time. Like the institutional church its doors should never be closed. Library centers, art centers, and amusement halls of the highest character ought to be housed in our school buildings. In this way would be secured the greatest prevention of crime. The time has come when no man or woman can occupy a high place in the world's work, or in places of trust, who is not equipped with a fair education and a true sense of the relationships of the race. There is no way to find these relations except by living a life of interdependence. One must be in the spirit of giving and taking kindness and responsibilities, especially giving.

While the school makes excellent provision for the physical

development by manual training, domestic science, gymnasium and athletics, it should also contribute to that other side of human nature, the emotional side, which demands music and an all-round art training, rhythm, grace, in movement as well as thought. Grace, vigor and strength help to make the perfect man or woman. Again, all the race loves a story and loves to live over the experiences of the race. So dramatic art is a most essential element in a curriculum for the social life. The school building, I repeat, should be always at the service of the people. Parents should organize associations, and co-operate to cultivate a living spirit of unity, thus giving the children's growing powers the legitimate outlet.

Oh, fathers and mothers, open your eyes and see what great privilege is yours by fulfilling your duty to your public schools. The public school, I repeat, is your own business, and the public school buildings are your places of business. Do not neglect them.

Now that the time is approaching when thousands of little children, and older boys and girls will be turned into the street with nothing to do but learn vice and wrong, let us make a heroic effort to keep the school buildings open for business, and so enter into competition with the saloons and street corners. In this way we shall save our city from a generation of criminals. These little minds are eager to know, the hands are aching to do something, and the dear helpless mothers are begging us to save their children. Our recent terrible strike troubles that have cost so much life, happiness, and money, would never have been, if every one of these men had been thoroughly educated in the principles that underlie our public-school system. Every child saved from the street this summer will save ten times what it costs to keep him in the vacation school, for the street is the school of crime. Let us bond our city or do something to meet the expense of placing a vacation school in every public-school building.

EDUCATION FROM THE GENETIC POINT OF VIEW[1]

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The genetic conception of education is not new. The fundamental principle of genetic pedagogy — that of adaptation of education to the sequence of the stages of individual development — is at least as old as Comenius; but a point of view means nothing unless it enables one to see facts as well as to dream dreams. The result of modern child-study has been to give the insight that the only way to make this principle of adaptation vital is to find out by careful inductive study just what is the actual condition of children at different stages of growth and development. My purpose this morning is to recount some of the facts that have made the genetic point of view vital.

Fortunately, you are all familiar with the modern doctrines that education is a process; that the child is a different creature from the adult; that the child differs from the adolescent; that the child differs from the child at different stages of its development; that stages low and imperfect may be significant because preparatory to higher stages; that the child should be a child before he becomes a man; that the best guarantee of normal maturity is normal immaturity; that, as Froebel put it, the full and complete development of each stage is necessary for the development of succeeding stages; and again, on the social side, that the child is not so much fitting himself for society, but that he now is a member of society; that the school may represent society in embryo; that the teacher is primarily a member of this social group; that, as Professor Dewey puts it, the school life and the home life should be one and the same; that the purpose of the school is to introduce to the fundamental, constructive, productive

[1] Paper read before the Department of Child Study of the National Educational Association, Asbury Park, N. J., July 7, 1905.

social activities; and that here, too, everything must be adapted to the child's own social experience.

Such familiar doctrines are based upon the genetic interpretation of facts. There are some other truths with which you are not perhaps so familiar. First of all, certain physiological facts.

Besides the obvious facts of growth and development which are of vital importance to education, there are certain more specific characteristics of the child's organism which are of practical importance. The child, for example, has a different circulatory system from the adult. The child's heart is relatively small, his arteries relatively large. During the period of development the heart grows very rapidly, and after adolescence it is relatively large, while the arteries are relatively small and narrow; or, more concretely, measurements have shown that during the period of growth the volume of the heart increases twelvefold, but the width of the aorta only threefold; or for 100 cm. of height in case of the child the heart volume is 50 c.cm.; in case of the adult it is 150–190 c.cm. Thus during the school period there is a complete change of the circulatory type. This is a fact of great practical importance to be considered in all manual work and physical training, as well as in the ordinary work and play of the child. Cardiac disturbance is quickly compensated for in the child's organism in a way impossible with the adult; hence short and rather violent activity is quite harmless for the child, although prolonged activity and feats of endurance are dangerous.

Again, in case of the child the constituents of the blood are different from those of the adult; especially is the protection against contagion less in case of the child. In the child the blood is less alkaline, and thus offers less resistance to micro-organisms, the germ-destroying or bacteriacidal power of the serum, according to Weill, is not so great, and the white corpuscles of the blood with bacteriacidal power are less. In case of the adult they are estimated at 70 in 100, but are only 28 at birth, 40 at the end of the first year, 54 in the third, 64 from the eighth to the tenth. That is, the protective power of the blood is twice as great in case of the adult as in case of the young child. This difference, together with the child's inferior protection in other ways, makes

contagious diseases especially dangerous in the kindergarten and early primary grades. This is not a mere matter of theoretical speculation, but statistics show that 90 per cent. of all deaths from the common contagious diseases — such as measles, whooping-cough, and the like — occur before the age of ten; and an extensive study of measles in Munich shows that while between the years two and five the fatal cases were 5 per cent. of all, between the ages of six and ten, they were only 0.4 per cent. In other words, if an epidemic of measles occurs in the kindergarten, the chances are that four children in one hundred cases will die; if the epidemic can be postponed until the primary school, the chances are that only four in one thousand will die.

Another specially important difference between the child and the adult is in the activity of the lymph. This gives a child added protection from certain contagious diseases; but, on the other hand, carries its own dangers with it. Experiments upon animals are instructive here. An artificial opening made into the thoracic duct of a young dog furnished lymph to the amount of between one-sixth and one-tenth of the body weight within one day, while from an adult dog lymph amounting to only one-tenth to one-sixteenth of the body weight was obtained. In the same way the lymph apparatus in the young child and adolescent is more active than in the adult.

Says Dr. Jacobi:

> This is why the condition of the lymph glands in the young is of such importance. Whenever there is any infection of the mucous membrane, the infecting poison is carried off to the next gland, where there is a stopping-place. That gland will become the seat of irritation or swelling. That is why . . . . whenever there is only a slight diarrhea, no matter from what cause, ... lymph bodies in the neighborhood will swell. Unless such a diarrhea is soon stopped, the irritation will continue, congestion, inflammation, swelling of the glands will ensue, and the structure of these neighboring glands will be changed.

Other facts of practical significance are the different growth-rates of different organs at different periods, the immaturity of special organs demanding special care, the undeveloped eyes of young children, the danger to the naso-pharynx, ear, and mouth from hypertrophied tonsils, and the like, the undeveloped voice

social activities; and that here, too, everything must be adapted to the child's own social experience.

Such familiar doctrines are based upon the genetic interpretation of facts. There are some other truths with which you are not perhaps so familiar. First of all, certain physiological facts.

Besides the obvious facts of growth and development which are of vital importance to education, there are certain more specific characteristics of the child's organism which are of practical importance. The child, for example, has a different circulatory system from the adult. The child's heart is relatively small, his arteries relatively large. During the period of development the heart grows very rapidly, and after adolescence it is relatively large, while the arteries are relatively small and narrow; or, more concretely, measurements have shown that during the period of growth the volume of the heart increases twelvefold, but the width of the aorta only threefold; or for 100 cm. of height in case of the child the heart volume is 50 c.cm.; in case of the adult it is 150–190 c.cm. Thus during the school period there is a complete change of the circulatory type. This is a fact of great practical importance to be considered in all manual work and physical training, as well as in the ordinary work and play of the child. Cardiac disturbance is quickly compensated for in the child's organism in a way impossible with the adult; hence short and rather violent activity is quite harmless for the child, although prolonged activity and feats of endurance are dangerous.

Again, in case of the child the constituents of the blood are different from those of the adult; especially is the protection against contagion less in case of the child. In the child the blood is less alkaline, and thus offers less resistance to micro-organisms, the germ-destroying or bacteriacidal power of the serum, according to Weill, is not so great, and the white corpuscles of the blood with bacteriacidal power are less. In case of the adult they are estimated at 70 in 100, but are only 28 at birth, 40 at the end of the first year, 54 in the third, 64 from the eighth to the tenth. That is, the protective power of the blood is twice as great in case of the adult as in case of the young child. This difference, together with the child's inferior protection in other ways, makes

contagious diseases especially dangerous in the kindergarten and early primary grades. This is not a mere matter of theoretical speculation, but statistics show that 90 per cent. of all deaths from the common contagious diseases — such as measles, whooping-cough, and the like — occur before the age of ten; and an extensive study of measles in Munich shows that while between the years two and five the fatal cases were 5 per cent. of all, between the ages of six and ten, they were only 0.4 per cent. In other words, if an epidemic of measles occurs in the kindergarten, the chances are that four children in one hundred cases will die; if the epidemic can be postponed until the primary school, the chances are that only four in one thousand will die.

Another specially important difference between the child and the adult is in the activity of the lymph. This gives a child added protection from certain contagious diseases; but, on the other hand, carries its own dangers with it. Experiments upon animals are instructive here. An artificial opening made into the thoracic duct of a young dog furnished lymph to the amount of between one-sixth and one-tenth of the body weight within one day, while from an adult dog lymph amounting to only one-tenth to one-sixteenth of the body weight was obtained. In the same way the lymph apparatus in the young child and adolescent is more active than in the adult.

Says Dr. Jacobi:

> This is why the condition of the lymph glands in the young is of such importance. Whenever there is any infection of the mucous membrane, the infecting poison is carried off to the next gland, where there is a stopping-place. That gland will become the seat of irritation or swelling. That is why . . . . whenever there is only a slight diarrhea, no matter from what cause, ... lymph bodies in the neighborhood will swell. Unless such a diarrhea is soon stopped, the irritation will continue, congestion, inflammation, swelling of the glands will ensue, and the structure of these neighboring glands will be changed.

Other facts of practical significance are the different growth-rates of different organs at different periods, the immaturity of special organs demanding special care, the undeveloped eyes of young children, the danger to the naso-pharynx, ear, and mouth from hypertrophied tonsils, and the like, the undeveloped voice

of the child, and the strain especially upon boys at the period of mutation.

On the physical side, then, the aim of education from the genetic point of view is to give a child the opportunity for growth and development, and to foster the acquisition of habits of healthful activity. Many other things are desirable, but a child's first business is to grow. He may have another opportunity for the acquisition of knowledge, but the demands of development cannot wait.

On the mental side the contribution of genetic psychology and physiology is perhaps equally great, although it cannot be stated so concretely and definitely. As popularly believed, the child has less power of attention than the adult; contrary to popular opinion, he has also less memory power; but the chief differences may be summed up in one word — lack of experience.

The studies of children are in some important respects revolutionizing pedagogy. Attention is shifting from methods of teaching to methods of learning. The work has already passed from the stage of mere observation and crude speculation to the stage of analysis and experimentation. Concrete problems of school work and of economic and efficient methods of study are being investigated by careful methods in the laboratory.[2] Meyer has studied the difference between the methods and results of school work done in a group of children,and similar work done by the children alone, finding that usually the group work is superior. Schmidt has studied the home work of children as compared with the school work and found, on the one hand, that in the more mechanical work pupils do better in the school because of the stimulation from other pupils, while in original essays in the mother-tongue and the like they do better in the isolation of the home. Meumann has studied the most economical and efficient methods of learning by heart. A single concrete example must suffice. Suppose the school task be to learn a stanza of a poem; children, as well as most adults, usually adopt the method of learning by parts — first a few words or a line, with many repetitions, and then another phrase or line. Is this a good method? Which is better — to learn the stanza as a whole, or to learn it

[2] See *Archiv für die gesammte Psychologie*, passim.

by parts? By which method will it be learned in less time, with fewer repetitions, be remembered more permanently and accurately? Investigations upon many children, extending through several years, show clearly that, as a rule, with them as with adults, the method of learning as a whole is decidedly better. Somewhat less time is required by this method, a very much smaller number of repetitions suffices, and most important of all, confusion of association and possibility of error are lessened, while correct and healthful habits of association and of study are developed.

Such are some of the facts as I understand them; we have in the child a psycho-physical organism, unstable, immature, growing and developing irregularly at different periods and at different rates in different parts and organs. These are facts of the utmost practical importance in the everyday work of the school. But, while we are primarily concerned with such concrete facts, we may stop for a moment to glance at the wider relations of these facts. Modern biological study has enormously enlarged the genetic conception of education. It is hardly fanciful to draw an analogy between the adjustment of the individual that we call education and the adaptation and mutation of species in plants found by De Vries and others. And if this investigator is right in concluding that when a species is in the period of mutation, as he found the evening primrose, new species are easily formed, and, after this period is passed, new species cannot be formed, then something similar seems to be true of the individual. Without pushing the analogy too far, in general it seems to be true that during the nascent period new acquisitions and adaptations can easily be made. After the nascent period is passed, new acquisitions are made only with great difficulty or not at all. The great lesson is one that teachers and parents are slow to learn — that nature works by times and seasons. We cannot forestall her without danger. We cannot let the moment of opportunity pass without irrevocable loss. Perhaps each organ has its nascent period when the conditions are most favorable for the acquisition of function, and the skill of the educator is put to its greatest test in determining when the favorable opportunity for training occurs.

When one says that hygiene and sound pedagogy fear premature and unrelated developments, and that the best guarantee of normal maturity is normal immaturity, it means very little; but when one studies the developing nervous system of young animals, all this becomes very concrete and emphatic. I know of no more interesting illustration of this than the studies of the guinea pig, made by Miss Allen. The guinea pig develops rapidly, and it is mentally precocious at a very early age. The white rat, on the other hand, develops relatively slowly. At birth the guinea pig has all its senses, pretty well-developed muscles, and is psychically mature at the age of three or four days. The white rat at birth, on the other hand, is undeveloped, blind, deaf, naked, his nervous system unmedullated, his muscular system without control. He does not gain the power of vision for sixteen or seventeen days, of hearing for perhaps thirteen days, nor become psychically mature for from twenty-four to twenty-seven days. The result of the precocious development of the guinea pig as compared with the slower development of the white rat appears in the education of the two animals.

As Miss Allen puts it:

> When the guinea pig has forced his way through a labyrinth, he has reached the end of his psychical powers. He cannot pull a latch nor push a bolt; he will not depress an inclined plane, chew a string, nor stamp his foot. . . . . The experience of the white rat extends to strange combinations of wires and springs, and all the delightful surprises revealed by secret doors; but when the guinea pig has turned the proper number of corners, his dinner must be waiting for him or he does not get it. The white rat at three days is just learning to crawl, has never seen an object, and remembers nothing. The guinea pig at that age has triumphantly recalled a complex path, at the end of which he sits eating his well-deserved carrot. At twenty-three days the rat is lifting latches neatly and forming what Hobhouse calls "practical judgments" as to the value of an inclined plane, in a situation at the center of which is his food — a desired thing, an end. The guinea pig is still wearing out the floor of the same labyrinth.

And, again, to quote Miss Allen:

> The contrasting features in the two animals are their nervous systems. In the one a mature nervous system is accompanied by psychical maturity; in the other, neural immaturity permits great psychical development.

If more were needed to show the importance of the genetic point of view, the errors that result from the lack of it would be

enough. I have time for but a single illustration. In medicine and hygiene there is always danger, if one lacks the genetic point of view, of treating the diseases incidental to growth and development, especially the nervous diseases — neuroses of development as they are technically called — in the same way that one would traet similar diseases in adults. In a word, there is danger of mistaking incidents of development for neuroses of degeneration. A concrete case in point has recently come to my attention.

An hysterical boy of fifteen was committed to a hospital. It was found that he had certain cardiac symptoms, precordial pain, and the like; and the physician to whom the boy's case was allotted, apparently having had more experience with old men than with children, treated him by giving one-hundredth of a grain of nitroglycerin three times a day. The probability is that the boy's heart will be injured for life; whereas with care, and a judicious use of iron and other tonics, the boy would have outgrown the cardiac trouble along with his hysteria. Such treatment of an adolescent is so atrocious that it is hardly credible that any reputable physician could be guilty of such an error. Apparently it was a case of mistaking a neurosis of development for a disease of adult life, on account of lack of the genetic point of view.

Teachers, as a result of their special work, are very likely to fall into similar errors. The defects and even the wickedness of children and youth, usually mere psychoses of development, are often taken too seriously by both teachers and parents, and the error of mistaking a psychosis of development for a sign of degeneracy is perhaps no less serious than that of a physician who gives nitroglycerin to the adolescent. If child-study had done no more than to give teachers the genetic point of view, all the labor expended would be well repaid; for here they are prone to err. If they do not adopt the nitroglycerin method of discipline, they are apt to desire a guinea-pig form of prematurity.

Everywhere today teachers and students are studying children; some in the laboratory with carefully controlled conditions; some by the questionnaire method — *la méthode démocratique,* as the French call it; others by mere observation and reminiscence, often by methods crude and unreliable. What is the result

of all this? What does it all amount to? Some of this work has yielded practical results. Some of it has illustrated the genetic point of view. All, I believe, has been valuable. For a single illustration, in the city where I live, the students of the normal school observe children as they have opportunity, and record isolated facts, sometimes the significant, more often the trivial and banal. There are tens of thousands of such reports in the archives of the school. Each year adds something to this store. Is that all? By no means. The students in this work acquire the genetic point of view, the right attitude toward children; and Principal Russell says that reports from graduates are to the effect that the bad boys and the defective become objects of special interest and study.

It is difficult to describe a point of view, but the point of view is everything. It determines what we see and what we are unable to see. In every profession, especially perhaps in the teacher's calling, the development of the professional point of view soon inevitably makes it impossible for one to see things as they really are. The attainment of the genetic point of view would save teachers from much of this scholastic blindness. It would save them from worry over defects and imperfections, and give the insight that education is a process, and that normal development implies imperfection and the gradual approximation to higher stages and higher ideals. It would revolutionize the teacher's calling, and the teacher's task would become a part of the great world-process of evolution in human life and human society. Again, it would save the school from what Professor James calls "the modern textbook of Moloch, in whose belly the souls of living children are turned to ashes," and from the mechanism of artificiality and traditional examination, classification, and grading. It would emancipate them from the idolatry of methods. It would save them from overstimulation and overpressure, and from that overstraining which means arrest of development. In a word, it would make the aim of the modern school development, health, individualization, and the opportunity for spontaneous intercourse with nature and society.

ANNOUNCEMENT

Among the most significant educational events of the year is the annual meeting of the Western Drawing and Manual Training Teachers' Association. This organization, which for ten years was limited to the drawing teachers, found it advisable, two years ago, to expand by a union with the manual-training teachers. This fact in itself indicates the trend of modern education.

The keynote of the meetings held in Chicago this spring, is denoted by the address by Miss Jane Addams on the "Social Value of Handicraft." The problems of modern industrialism are forcing themselves upon the educational profession.

That art is regarded by these people as a factor in daily life, was apparent in all the discussions of these most interesting meetings.

The members of this association are usually compelled to do pioneer work in the movements toward better educational conditions. Their exhibitions and discussions are therefore of value as denoting what has been actually accomplished under the average school conditions. The School of Education therefore looks forward to an interesting and profitable conference when it entertains the Association next year.

The twelfth annual meeting of the Western Drawing and Manual Training Association was held in Chicago April 25–28, inclusive. The session was a most successful one both as to program and attendance. It was voted to accept the invitation of President Harper to meet at the University of Chicago next year.

The following officers were elected:

President — Florence E. Ellis, Grand Rapids.
Vice-President — Charles A. Bennett, Peoria.
Secretary — Mary E. Chamberlain, Saginaw.
Treasurer — Louis A. Bacon, Indianapolis.
Auditor — J. E. Painter, Minneapolis.
Executive Committee — Lillian S. Cushman, Chicago; Frank A. Selden, Chicago; Charles S. Hammock, Cedar Falls; Welhelmina Seegmiller, Indianapolis.
Chairman Press Committee — Emma March, Chicago.

EDITORIAL NOTES

Waste in Teaching

The usual school curriculum is a misfit. Much of the material proposed cannot be presented properly, and much that is presented the youthful mind is in no condition to apperceive. In organization and arrangement it does not correspond to the natural processes of thinking, and it fails to stimulate and nourish mind-growth. There is, on this account, indefinite waste in the work of teaching.

The operations of nature often follow the path of a circle with a recurrence in cycles. The stalk of corn takes up from the soil small quantities of materials which, after serving their purpose, are returned to the earth again, and the process is repeated in endless generations and cycles of vegetation.

Educative Process a Circle

The educative process, too, when complete, follows the path of a circle, and in some respects the growth of the human being is like that of the plant. But there is a difference — an important difference. In the plant the materials are organized into complex compounds, which in time become separated and reduced to the simple and original forms. At every stage of the process the transformations deal with materials, and nothing but materials. But in human growth, in the transformations of the materials which minister to it there

Spiritual By-Product

is a by-product in the shape of a spiritual output that at once lifts the development of a human being above the growth of a vegetable.

It is this spiritual by-product of material transformations that is the chief concern of the teacher; and the trouble is that nobody is able to understand it. The lime, the carbon, and the water, having performed their function in the corn, passively return to earth and air, leaving no trace behind. But in the human being there is accompanying these changes a spiritual output that may be good or may be bad — it will never be neutral and passive. It is here that the teacher finds his problem. It is his special business to see that the uncertainties that are ordinarily involved in

the spiritual result become certainties in the direction of righteousness.

Toward this end comparatively little has been accomplished. Some of our philosophers have turned pessimists and given it up.

Outcome of Education Uncertain

The most diabolic and fiendishly artistic crimes are frequently perpetrated by those who were long treated in childhood and youth with the educational process as it is commonly practiced. It seems that not only a little learning, but also a great deal, is often a most dangerous thing. Somewhere in the educational process there is a break, a lapse; something is overlooked; something is left out.

Looking at the educational process under the similitude of a circle, there are several things needed to make it complete. The

Parts of the Educational Process

omission of any one of these will make the spirit of man a wanderer upon the face of the earth, and open up to it all the possibilities of villainies that detract and defile.

Upon one part of the circle that describes the educative process lies the environment of the learner. This includes every-

Evironment

thing that is capable of producing any kind of an impression through any or all of the senses. This part the schools in the past have much neglected. The face of the scholar was turned from the face of nature. All the machinery of the school was devoted to strengthening this attitude. But the situation is improving. Through object-lessons, and nature-study, and in countless other ways, the pupil is placed in direct touch with the influences of his surroundings.

At another point on the circle is the individual himself. It is his function to transform the impressions received through the

The Individual

senses into a spiritual product. It is the sole office of the teacher, it is the chief business of method, to see that the impressions are so marshaled that the spiritual outcome shall be certain. Without this there is no education. Upon this point, too, the schools have been ignorant and indifferent. So long as the children were compelled to deal with symbols and empty formulas that possessed little significance for them, the impressions were faint and the spiritual result was weak. But the pupils are now in close touch with practically all

matters — physical and intellectual — that can influence a human being, and the spiritual product is robust. This is due to two things: to the substitution of interesting material for empty forms and symbols, and to improved and more skilful methods of presentation.

The Proper Emphasis in Education

Up to this time almost the whole emphasis in school-teaching, from infancy to maturity, has been placed and still is placed upon these two phases of instruction. Science with its field-work and laboratories, and history in its work of excavation and research, are but emphasizing the importance of concrete and interesting material as a basis for instruction. Departments of education in normal schools, colleges, and universities express the importance that now attaches to philosophic and skilful methods. Yet, in the face of all this, the world is still half afraid of the educated product. Nobody knows just what it will do; we appear to be no more sure that it will be upright than we were when educational schemes were less elaborate. College and university men may be found who contribute to the general welfare — they may be found also tangled up in all sorts of nefarious schemes. Hence the public is hesitating, doubtful, and half-afraid of education.

Education Made Safe

It is evident that the educative process is not complete; the circle is not entirely closed. The only thing that can ever make education safe is to have the spiritual output, the by-product of those physical transformations of the living body, immediately enter as an influence for good into the environment which was the source of the original impressions. At present the school does not do this. It assumes that the spiritual result will some time later beneficently affect the environment; and in many cases it does; but it is largely a matter of chance, and our education is therefore not scientific. Character is not assured until the spiritual product has made itself felt in the uplift of the surroundings which gave it birth.

Weak Spot in the Schools

Here is the vitally, fatally weak spot in the schools. While they are furnishing an increasing number of opportunities through material and method for the pupils to derive ideas from their surroundings, they by no means furnish adequate or corresponding opportunities for them to work their impulses back into their surroundings again.

A man looks out over a plague-smitten city; from what he sees he forms an idea — a spiritual product — as to what should be done. He plans a system of drainage and other measures which finally dispel the pestilence, and his surroundings are left upon a higher plane than that on which be found them. The new generation begins where his work ended and repeats the process; thus through generation after generation in endless cycles the elevation of the race proceeds.

Educative Process Illustrated

In this illustration there is the perfect type of the educative process. The man not only blesses his city; he at the same time educates himself — constructs character. Nobody doubts him, nobody fears him; everyone knows just what he will do. He is the only type of a citizen that is absolutely safe, and but few of such appear in each generation. "By their *fruits* ye shall KNOW them." The schools are almost wholly lacking in opportunities and means by which the pupil can make this beneficent connection with his environment. He has no means by which he can close the circle, and his spiritual product, his impulses, waste themselves away in the ether. No human being was ever educated by such a process.

Slowly are the schools waking up to this fact. By almost imperceptible degrees the pupils are allowed to exercise the means by which they may work their ideas out in their surroundings. This is the real meaning of all the forms of art, and of hand-work, that are gradually finding place in the curriculum. They are not there merely to make the fingers nimble, any more than the object is introduced simply to render the senses alert. It is their immediate purpose to afford the pupil a direct means of putting himself, his spiritual output, as a living impulse, into his environment that he may uplift it. When pupils are *all* trained in this part of the educative process, there is every reason to believe that *all* of them will become educated; that *all* of them will become safe and reliable citizens. It is the final step, the closing of the circle through the individual's reaction upon his environment, that actually assures character. The various forms of handwork are admirably adapted to this end. Domestic sci-

Meaning of Hand-work

Educating all the Children

ence lies at the foundation of the health and happiness of the race. Its glaring need is evident everywhere. In this subject the pupils have the fullest opportunity of putting into immediate operation, for the benefit of all concerned, every lesson that is learned.

Through the artistic and industrial aspects of clay-modeling, woodwork, metal-work, textiles, sewing, bookbinding, printing, drawing, painting and design, no home and no school need be without work that is both useful and beautiful. Early ideas of taste in matters pertaining to dress and decoration exert constantly a powerful influence in the development of character. All of these activities meet the growing demand for finer adaptations and more delicate adjustments, that materials may be used with greater economy, more artistic effect, and for a more exalted purpose.

Function of the Occupations

These occupations in the school are intended to close the gap that ordinarily exists in the circle — in the educative process — between the individual and his environment. It is they that finally root in the human being the elements of character. There is no doubt what a man or woman so trained will do. He can be trusted to make things better, and through the making to become a stronger and finer character himself.

Creative Work

It is this part of the educative process that calls for original and creative work of the highest type. Imitation will not answer; for the environment is to be changed, made better, and new ways and means must be devised. It turns education from a copying process into one of original research. It insures a re-examination of the motive at every step, that the highest ends may be sought and attained. Through the continual search into the needs of his surroundings, the moral sense of the individual is immeasurably quickened, and the motive itself in time becomes firmly established. It is then, and not until then, that the right type of citizenship is assured.

W. S. J.